ANALOG DEVICES

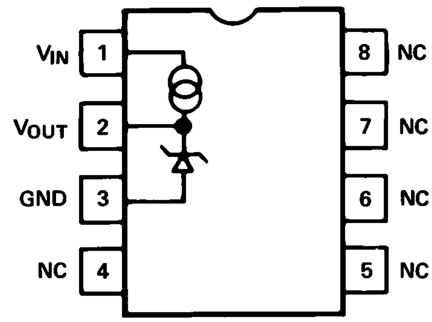
Low Cost, Precision 2.5 V IC References

AD1403/AD1403A*

FEATURES

Improved, Lower Cost, Replacements for Standard 1403, 1403A
3-Terminal Device: Voltage In/Voltage Out
Laser Trimmed to High Accuracy: 2.500 V ± 10 mV (AD1403A)
Excellent Temperature Stability: 25 ppm/°C (AD1403A)
Low Quiescent Current: 1.5 mA max
10 mA Current Output Capability
Low Cost
Convenient Mini-DIP Package

FUNCTIONAL BLOCK DIAGRAM



PRODUCT DESCRIPTION

The AD1403 and AD1403A are improved three-terminal, low cost, temperature compensated, bandgap voltage references that provide a fixed 2.5 V output voltage for inputs between 4.5 V and 40 V. A unique combination of advanced circuit design and laser-wafer-trimmed thin-film resistors provides the AD1403/AD1403A with an initial tolerance of ±10 mV and a temperature stability of better than 25 ppm/°C. In addition, the low quiescent current drain of 1.5 mA (max) offers a clear advantage over classical Zener techniques.

The AD1403 or AD1403A is recommended as a stable reference for all 8-, 10- and 12-bit D-to-A converters that require an external reference. In addition, the wide input range of the AD1403/AD1403A allows operation with 5 volt logic supplies, making these devices ideal for digital panel meter applications and when only a single logic supply is available.

The AD1403 and AD1403A are specified for operation over the 0°C to +70°C temperature range. The AD580 series of 2.5 volt precision IC references is recommended for applications where operation over the –55°C to +125°C range is required.

PRODUCT HIGHLIGHTS

1. The AD1403A offers improved initial tolerance over the industry-standard 1403A: ±10 mV versus ±25 mV at a lower cost.
2. The three-terminal voltage in/voltage out operation of the AD1403/AD1403A provides a regulated output voltage without any external components.
3. The AD1403/AD1403A provides a stable 2.5 V output voltage for input voltages between 4.5 V and 40 V making these devices ideal for systems that contain a single logic supply.
4. Thin film resistor technology and tightly controlled bipolar processing provide the AD1403A with temperature stabilities of 25 ppm/°C.
5. The low 1.5 mA maximum quiescent current drain of the AD1403 and AD1403A makes them ideal for CMOS and other low power applications.

***Protected by U.S. Patent Numbers: 3,887,863, RE30,586.**

REV. A

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AD1403/AD1403A–SPECIFICATIONS (V_{IN} = 15 V, T_A = +25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage (I_O = 0 mA)	V_O				
AD1403		2.475	2.500	2.525	V
AD1403A		2.490	2.500	2.510	
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$				ppm/°C
AD1403			10	40	
AD1403A			10	25	
Output Voltage Change, 0°C to +70°C	ΔV_O				mV
AD1403				7.0	
AD1403A			4.4		
Line Regulation	Reg_{in}				mV
(15 V ≤ V_{IN} ≤ 40 V)			1.2	4.5	
(4.5 ≤ V_{IN} ≤ 15 V)			0.6	3.0	
Load Regulation (0 mA < I_O < 10 mA)	Reg_{load}			10	mV
Quiescent Current (I_O = 0 mA)	I_I		1.2	1.5	mA

Specifications subject to change without notice.

MAXIMUM RATINGS (T_A = +25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Input Voltage	V_{IN}	40	V
Storage Temperature	T_{STG}	–25 to 100	°C
Junction Temperature	T_J	+175	°C
Operating Ambient Temperature Range	T_A	0 to +70	°C

ORDERING GUIDE

Model	Initial Tolerance	Package Option*
AD1403	±25 mV	N-8
AD1403A	±10 mV	N-8

*N Plastic DIP.

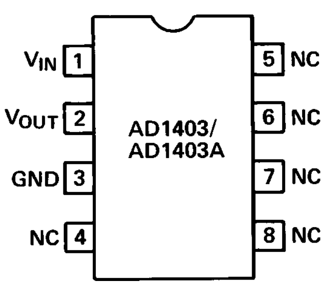


Figure 1. AD1403/AD1403A Connection Diagram

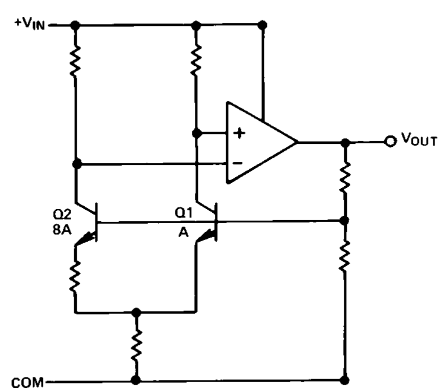


Figure 2. Simplified AD1403 Schematic

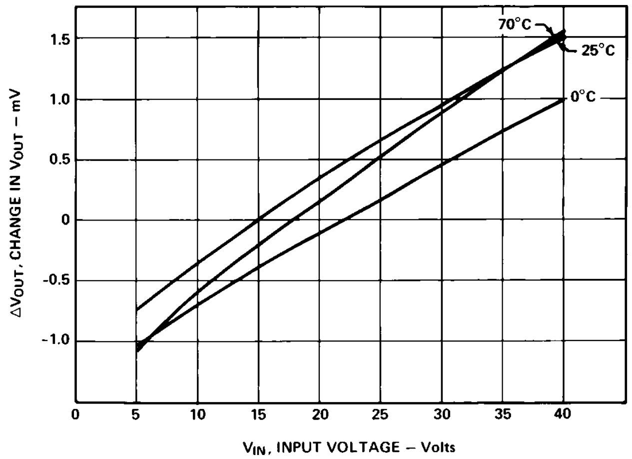


Figure 3. Typical Change in V_{OUT} vs. V_{IN} (Normalized to V_{OUT} @ V_{IN} = 15 V @ T_C = 25°C)

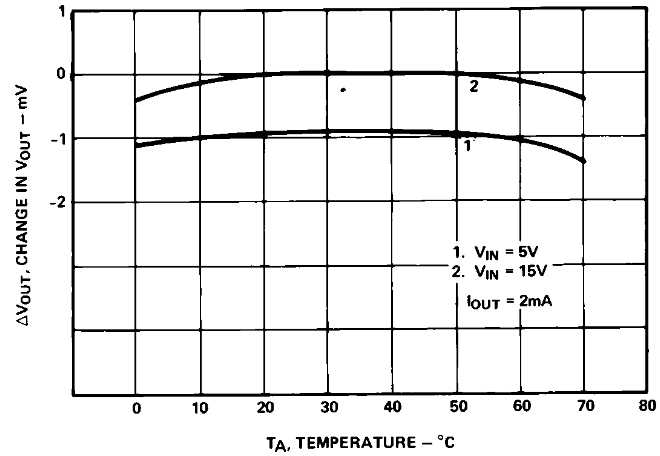


Figure 6. Change in V_{OUT} vs. Temperature (Normalized to V_{OUT} @ V_{IN} = 15 V)

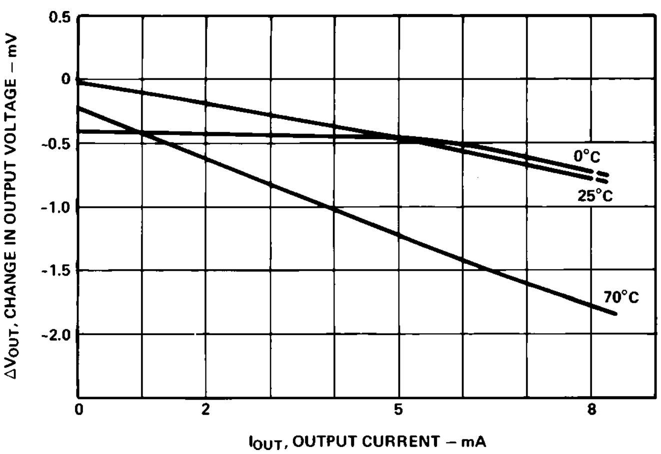


Figure 4. Change in Output Voltage vs. Load Current (Normalized to V_{OUT} @ V_{IN} = 15 V, I_{OUT} = 0 mA)

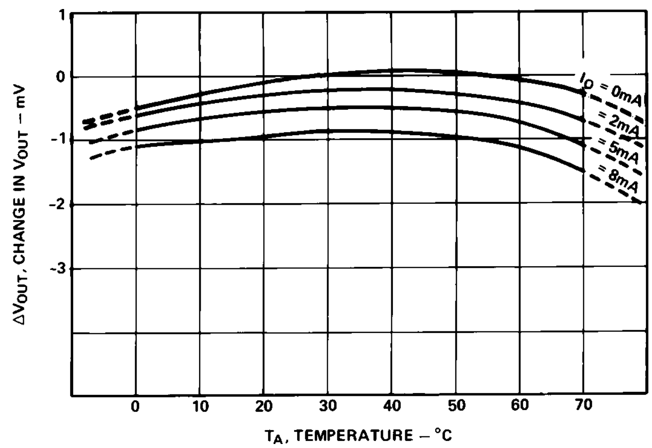


Figure 7. Change in V_{OUT} vs. Temperature (Normalized to V_{OUT} @ V_{IN} = 15 V, I_{OUT} = 0 mA)

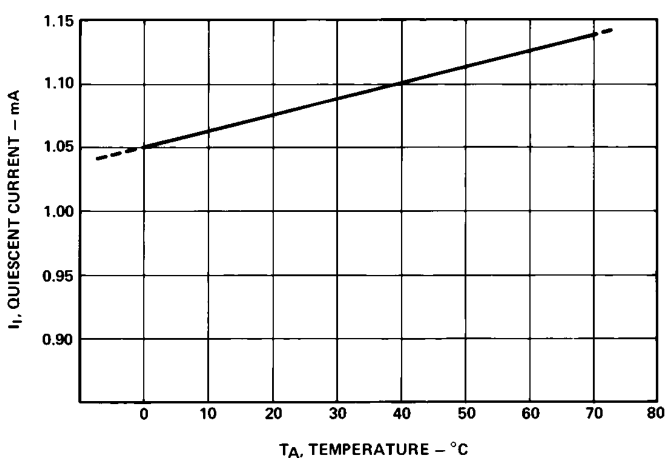


Figure 5. Quiescent Current vs. Temperature (V_{IN} = 15 V, I_{OUT} = 0 mA)

VOLTAGE VARIATION VS. TEMPERATURE AND LINE

Some confusion exists in the area of defining and specifying reference voltage error over temperature. Historically, references are characterized using a maximum deviation per degree Centigrade; i.e., 10 ppm/°C. However, because of the inconsistent nonlinearities in Zener references (butterfly or "S" type characteristics), most manufacturers use a maximum limit error band approach to characterize their references. This technique measures the output voltage at 3 to 5 different temperatures and guarantees that the output voltage deviation will fall within the guaranteed error band at these discrete temperatures. This approach, of course, makes no mention or guarantee of performance at any other temperature within the operating temperature range of the device.

The consistent Voltage vs. Temperature performance of a typical AD1403 is shown in Figure 6. Note that the characteristic is quasi-parabolic, not the possible "S" type characteristics of classical Zener references. This parabolic characteristic permits a maximum output deviation specification over the device's full operating temperature range, rather than just at 3 to 5 discrete temperatures.

The AD1403 exhibits a worst-case shift of 7.5 mV over the entire range of operating input voltage, 4.5 volts to 40 volts. Typically, the shift is less than 1 mV as shown in Figure 3.

THE AD1403A AS A LOW POWER, LOW VOLTAGE PRECISION REFERENCE FOR DATA CONVERTERS

The AD1403A has a number of features that make it ideally suited for use with A/D and D/A data converters used in complex microprocessor-based systems. The calibrated 2.500 volt output minimizes user trim requirements and allows operation from a single low voltage supply. Low power consumption (1.5 mA quiescent current) is commensurate with that of CMOS-type devices, while the low cost and small package complements the decreasing cost and size of the latest converters.

Figure 8 shows the AD1403A used as a reference for the AD7524 low-cost 8-bit CMOS DAC with complete micro-

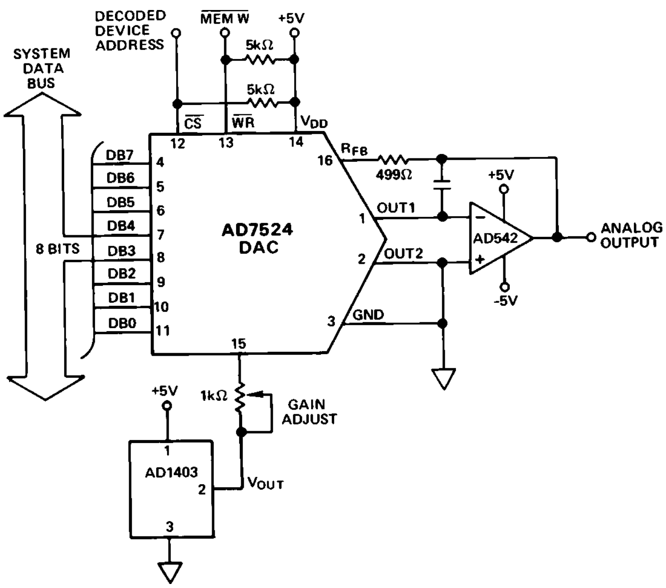


Figure 8. Low Power, Low Voltage Reference for the AD7524 Microprocessor-Compatible 8-Bit DAC

processor interface. The AD1403A and the AD7524 are specified to operate from a single 5 volt supply; this eliminates the need to provide a +15 volt power supply for the sole purpose of operating a reference. The AD7524 includes an 8-bit data register, and address decoding logic; it may thus be interfaced directly to an 8- or 16-bit data bus. Only 300 μA of quiescent current from the single +5 volt supply is required to operate the AD7524 which is packaged in a small 16-pin DIP. The AD542 output amplifier is also low power, requiring only 1.5 mA quiescent current. Its laser-trimmed offset voltage preserves the ±1/2 LSB linearity of the AD7524KN without user trims and it typically settles to ±1/2 LSB in less than 5 microseconds. It will provide the 0 volt to –2.5 volt output swing from ±5 volt supplies.

THE AD1403 AS A PRECISION PROGRAMMABLE CURRENT SOURCE

The AD1403 is an excellent building block for precision current sources. Its wide range of operating voltages, 4.5 V to 40 V, along with excellent line regulation over that range (7.5 mV) result in high insensitivity to varying load impedances. The low quiescent current (I_I) of 1.5 mA (max) and the maximum specified maximum load current of 10 mA allows the user to program current to any value between 1.5 mA and 10 mA.

Figure 9a shows the AD1403 connected as a current source. Total current is equal to the quiescent current plus the load current. Most of the temperature coefficient comes from the quiescent current term I_I, which has a typical TC of 0.13%/°C (1300 ppm/°C). The load voltage (and hence current) TC is much lower at ±40 ppm/°C max (AD1403). Therefore, the overall temperature coefficient decreases rapidly as the load current is increased. Figure 9b shows the typical temperature coefficient for currents between 1.5 mA and 10 mA. Use of an AD1403A will not improve the TC appreciably.

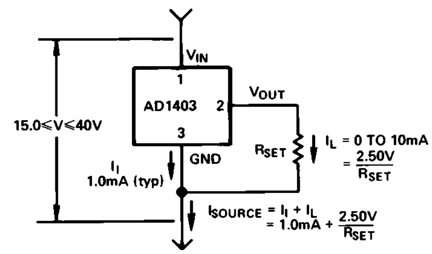


Figure 9a. The AD1403 as a Precision Programmable Current Source

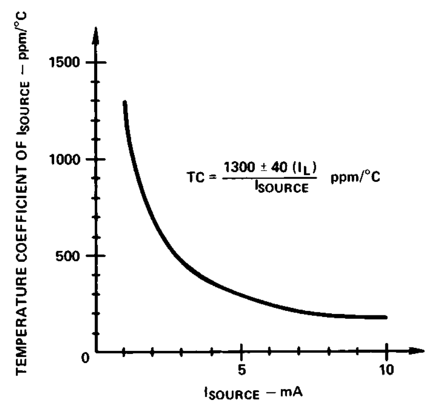
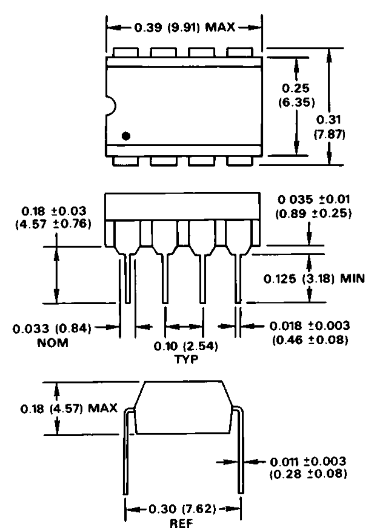


Figure 9b. Typical Temperature Coefficient of Current Source

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

8-Pin Mini-DIP (N)



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